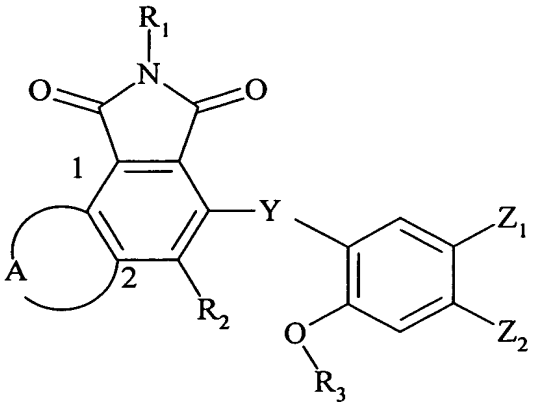
CLAIMS

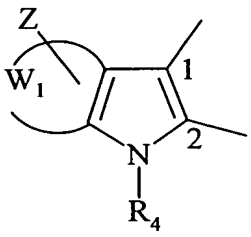
1. Compounds of formula (I) :



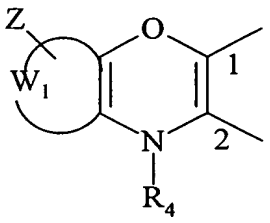
(I),

wherein :

- **A**, together with the carbon atoms to which it is bonded, represents a group of formula (a) or (b) :



(a)



(b),

wherein :

- ✧ W_1, together with the carbon atoms to which it is bonded, represents a phenyl group or a pyridyl group,

- Z represents a group selected from hydrogen and halogen atoms and the groups linear or branched (C_1-C_6)alkyl, nitro, cyano, hydroxy, linear or branched (C_1-C_6)alkoxy, aryl, aryl-(C_1-C_6)alkyl (in which the alkyl moiety is linear or branched), aryloxy and aryl-(C_1-C_6)alkoxy (in which the alkoxy moiety is linear or branched) and NR_5R_6 wherein R_5 and R_6, which are identical or different, each independently of the other represents a group selected from a hydrogen atom and a linear or branched (C_1-C_6)alkyl group,

- R_4 represents a group selected from a hydrogen atom and the groups linear or branched (C_1-C_6)alkyl, aryl and aryl-(C_1-C_6)alkyl (in which the alkyl moiety is linear or branched) or a group -C(O)-OR'$_5$ wherein R'$_5$ represents a group selected from the groups linear or branched (C_1-C_6)alkyl, aryl and aryl-(C_1-C_6)alkyl (in which the alkyl moiety is linear or branched),

- Y represents a group selected from an oxygen atom and a methylene group,

- R_2 represents a hydrogen atom and, in that case:
  R_3 represents a group selected from a hydrogen atom and the groups linear or branched (C_1-C_6)alkyl, aryl, aryl-(C_1-C_6)alkyl (in which the alkyl moiety is linear or branched) and SO_2CF_3,

- or R_2 and R_3 form a bond,

- R_1 represents a group selected from a hydrogen atom and the groups linear or branched (C_1-C_6)alkyl, aryl and aryl-(C_1-C_6)alkyl (in which the alkyl moiety is linear or branched) or a linear or branched (C_1-C_6)alkylene chain substituted by one or more identical or different groups selected from -OR"$_5$ and -NR"$_5$R"$_6$ wherein R"$_5$ and R"$_6$ are as defined for R_5 and R_6 defined hereinbefore,

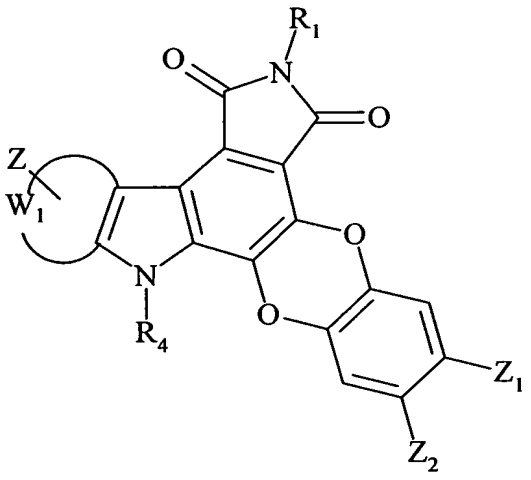
- Z_1 and Z_2 each represent a hydrogen atom or
  Z_1 and Z_2, together with the carbon atoms carrying them, form a phenyl group,

with the proviso that, when Z represents a hydrogen atom, R_1 is other than a hydrogen atom,

their enantiomers, diastereoisomers, N-oxide, and addition salts thereof with a pharmaceutically acceptable acid or base,

wherein "aryl" is to be understood as meaning a phenyl, naphthyl, dihydronaphthyl, tetrahydronaphthyl, indenyl or indanyl group, each of those groups being optionally substituted by one or more identical or different groups selected from halogen, linear or branched (C_1-C_6)alkyl, linear or branched (C_1-C_6)trihaloalkyl, hydroxy, linear or branched (C_1-C_6)alkoxy, and amino optionally substituted by one or two linear or branched (C_1-C_6)alkyl groups.

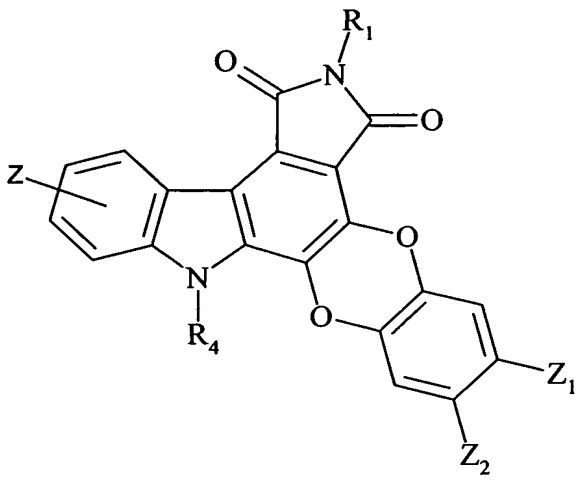
2. Compounds of formula (I) according to claim 1, characterised in that they represent compounds of formula (IA) :



(IA),

wherein R_1, R_4, W_1, Z, Z_1 and Z_2 are as defined for formula (I), their enantiomers, diastereoisomers, N-oxide, and addition salts thereof with a pharmaceutically acceptable acid or base.

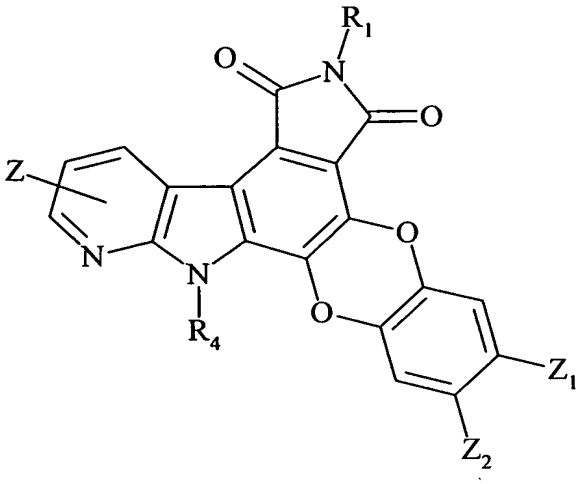
3. Compounds of formula (I) according to either claim 1 or claim 2, characterised in that they represent compounds of formula (IB) :



(IB),

wherein R_1, R_4, Z, Z_1 and Z_2 are as defined for formula (I), their enantiomers, diastereoisomers, N-oxide, and addition salts thereof with a pharmaceutically acceptable acid or base.

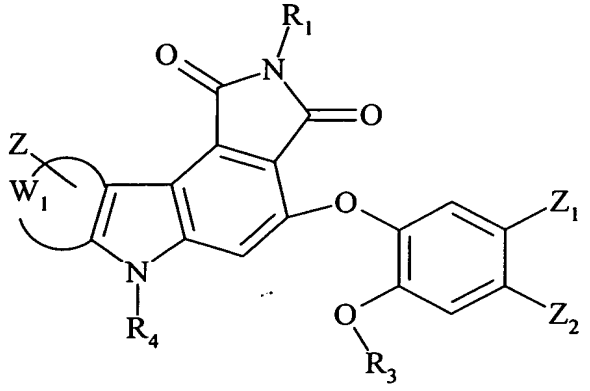
4. Compounds of formula (I) according to either claim 1 or claim 2, characterised in that they represent compounds of formula (IC) :



(IC),

wherein R_1, R_4, Z, Z_1 and Z_2 are as defined for formula (I), their enantiomers, diastereoisomers, N-oxide, and addition salts thereof with a pharmaceutically acceptable acid or base.

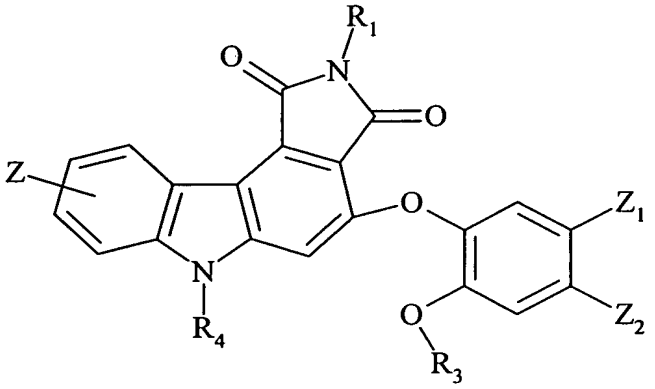
5. Compounds of formula (I) according to claim 1, characterised in that they represent compounds of formula (ID) :



(ID),

wherein R_1, R_3, R_4, W_1, Z, Z_1 and Z_2 are as defined for formula (I), their enantiomers, diastereoisomers, N-oxide, and addition salts thereof with a pharmaceutically acceptable acid or base.

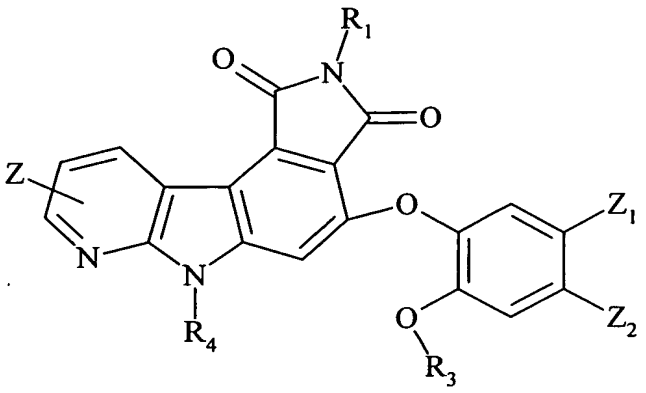
6. Compounds of formula (I) according to either claim 1 or claim 5, characterised in that they represent compounds of formula (IE) :



(IE),

wherein R_1, R_3, R_4, Z, Z_1 and Z_2 are as defined for formula (I), their enantiomers, diastereoisomers, N-oxide, and addition salts thereof with a pharmaceutically acceptable acid or base.

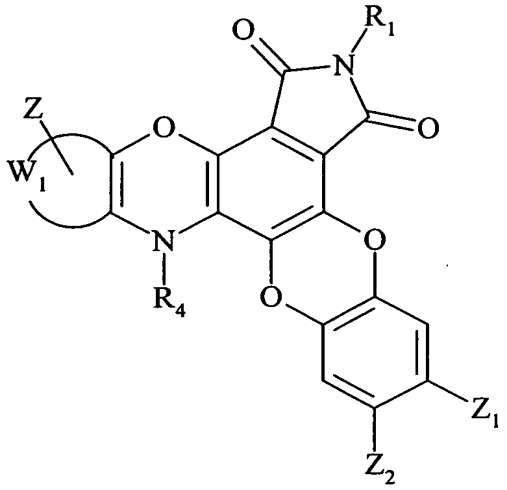
7. Compounds of formula (I) according to either claim 1 or claim 5, characterised in that they represent compounds of formula (IF) :



(IF),

wherein R_1, R_3, R_4, Z, Z_1 and Z_2 are as defined for formula (I), their enantiomers, diastereoisomers, N-oxide, and addition salts thereof with a pharmaceutically acceptable acid or base.

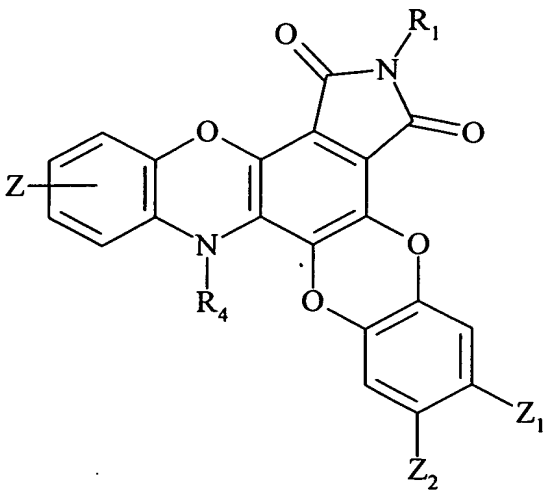
8. Compounds of formula (I) according to either claim 1 or claim 5, characterised in that they represent compounds of formula (IG) :



(IG),

wherein R_1, R_4, W_1, Z, Z_1 and Z_2 are as defined for formula (I), their enantiomers, diastereoisomers, N-oxide, and addition salts thereof with a pharmaceutically acceptable acid or base.

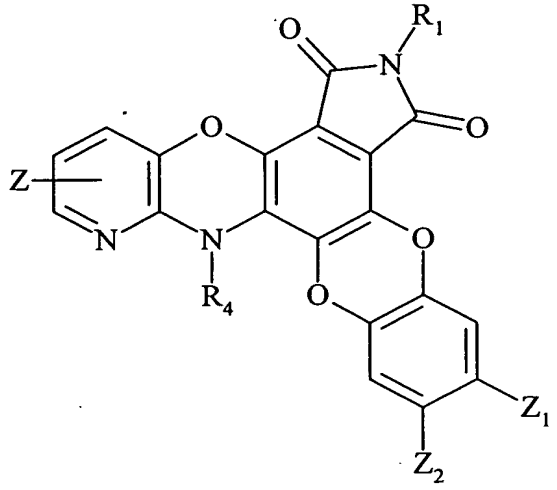
9. Compounds of formula (I) according to either claim 1 or claim 8, characterised in that they represent compounds of formula (IH) :



(IH),

wherein R_1, R_4, Z, Z_1 and Z_2 are as defined for formula (I), their enantiomers, diastereoisomers, N-oxide, and addition salts thereof with a pharmaceutically acceptable acid or base.

10. Compounds of formula (I) according to either claim 1 or claim 8, characterised in that they represent compounds of formula (IJ) :

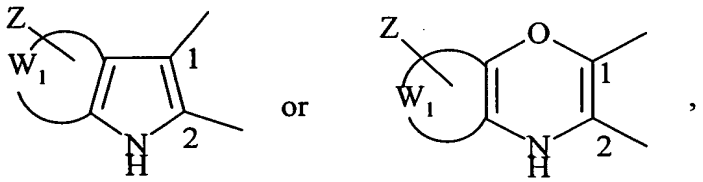


(IJ),

wherein R_1, R_4, Z, Z_1 and Z_2 are as defined for formula (I), their enantiomers, diastereoisomers, N-oxide, and addition salts thereof with a pharmaceutically acceptable acid or base.

11. Compounds of formula (I) according to any one of claims 1 to 10, characterised in that Z represents a hydrogen atom, halogen atom or hydroxy group, their enantiomers, diastereoisomers, N-oxide, and addition salts thereof with a pharmaceutically acceptable acid or base.

12. Compounds of formula (I) according to any one of claims 1 to 11, characterised in that A, together with the carbon atoms to which it is bonded, represents a group of formula :



,

their enantiomers, diastereoisomers, N-oxide, and addition salts thereof with a pharmaceutically acceptable acid or base.

13. Compounds of formula (I) according to any one of claims 1 to 12, characterised in that R_3 represents a hydrogen atom or a linear or branched (C_1-C_6)alkyl group, their enantiomers, diastereoisomers, N-oxide, and addition salts thereof with a pharmaceutically acceptable acid or base.

14. Compounds of formula (I) according to any one of claims 1 to 13, characterised in that R_1 represents a hydrogen atom, a linear or branched (C_1-C_6)alkyl group or a linear or branched (C_1-C_6)alkylene chain substituted by one or more identical or different groups selected from -NR_5R_6 wherein R_5 and R_6 are as defined for formula (I), their enantiomers, diastereoisomers, N-oxide, and addition salts thereof with a pharmaceutically acceptable acid or base.

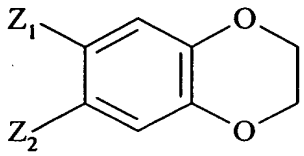
15. Compounds of formula (I) according to any one of claims 1 to 14, characterised in that Z_1 and Z_2 represent hydrogen atoms, their enantiomers, diastereoisomers, N-oxide, and addition salts thereof with a pharmaceutically acceptable acid or base.

16. Compounds of formula (I) according to claim 1, which are :

- 7-methyl[1,4]benzodioxino[2,3-a]pyrrolo[3,4-c]carbazole-6,8-dione,
- 10-fluoro-7-methyl[1,4]benzodioxino[2,3-a]pyrrolo[3,4-c]carbazole-6,8-dione,
- 11-fluoro-7-methyl[1,4]benzodioxino[2,3-a]pyrrolo[3,4-c]carbazole-6,8-dione,
- 7-[2-(dimethylamino)ethyl]-10-fluoro[1,4]benzodioxino[2,3-a]pyrrolo[3,4-c]-carbazole-6,8-dione,
- 10-hydroxy[1,4]benzodioxino[2,3-a]pyrrolo[3,4-c]carbazole-6,8-dione,
- 11-hydroxy[1,4]benzodioxino[2,3-a]pyrrolo[3,4-c]carbazole-6,8-dione,
- 7-[2-(dimethylamino)ethyl][1,4]benzodioxino[2,3-a]pyrrolo[3,4-c]carbazole-6,8-dione,
- 7-[2-(dimethylamino)ethyl]-10-hydroxy[1,4]benzodioxino[2,3-a]pyrrolo[3,4-c]-carbazole-6,8-dione,
- 7-[2-(dimethylamino)ethyl]-11-hydroxy[1,4]benzodioxino[2,3-a]pyrrolo[3,4-c]-carbazole-6,8-dione,
- 7-[2-(dimethylamino)ethyl][1,4]benzodioxino[2,3-e]pyrido[2',3':5,6][1,4]oxazino-[3,2-g]isoindole-6,8-dione,

their enantiomers, diastereoisomers, N-oxide, and addition salts thereof with a pharmaceutically acceptable acid or base.

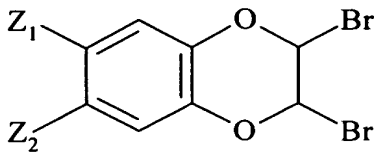
17. Process for the preparation of compounds of formula (I) according to claim 1, characterised in that there is used as starting material a compound of formula (II) :



(II),

wherein Z_1 and Z_2 are as defined for formula (I),

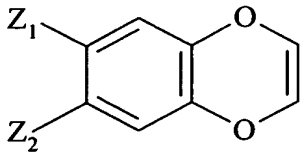
which compound of formula (II) is reacted with N-bromosuccinimide in the presence of benzoyl peroxide to yield the compound of formula (III) :



(III),

wherein Z_1 and Z_2 are as defined hereinbefore,

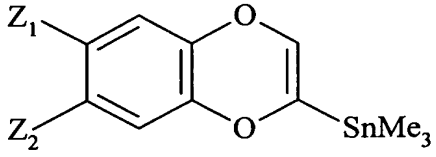
which compound of formula (III) is reacted with sodium iodide to yield the compound of formula (IV) :



(IV),

wherein Z_1 and Z_2 are as defined hereinbefore,

which compound of formula (IV) is reacted with n-butyllithium and then with trimethyltin chloride to yield the compound of formula (V) :

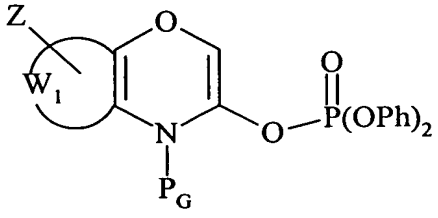


(V),

wherein Z_1 and Z_2 are as defined hereinbefore,

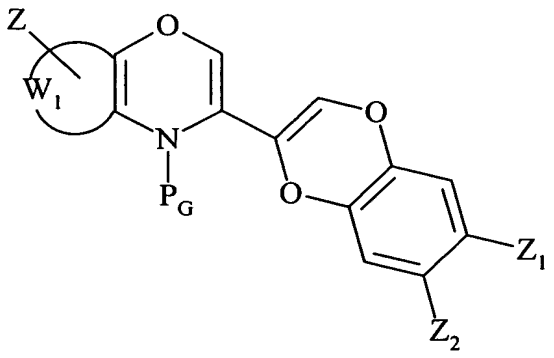
which compound of formula (V) is :

- either treated, in the presence of tetrakis(triphenylphosphine)palladium(0), with a compound of formula (VI) :



(VI),

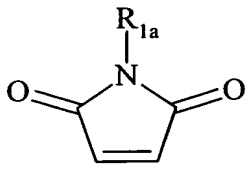
wherein P_G represents an amine-protecting group well-known in organic synthesis and W_1 and Z are as defined for formula (I), to yield the compound of formula (VII) :



(VII),

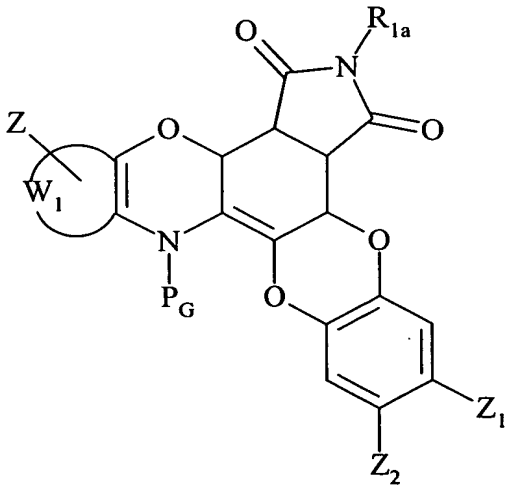
wherein P_G, Z, Z_1, Z_2 and W_1 are as defined hereinbefore,

which compound of formula (VII) is treated with a compound of formula (VIII) :



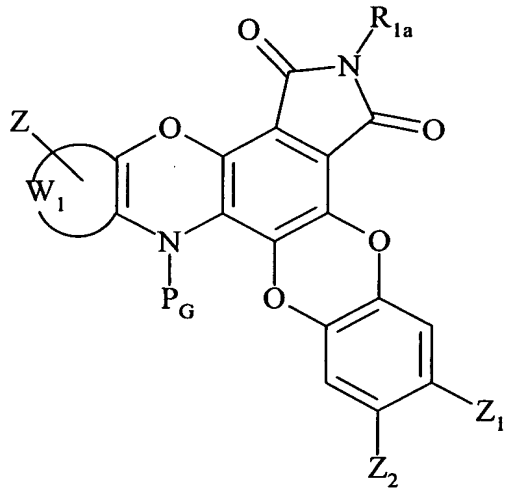
(VIII),

wherein R_{1a} represents a hydrogen atom or a methyl group, to yield the compound of formula (IX) :



(IX),

wherein P_G, R_{1a}, Z, Z_1, Z_2 and W_1 are as defined hereinbefore,
which compound of formula (IX) is treated with N-bromosuccinimide and benzoyl peroxide to yield the compound of formula (I/a), a particular case of the compounds of formula (I) :

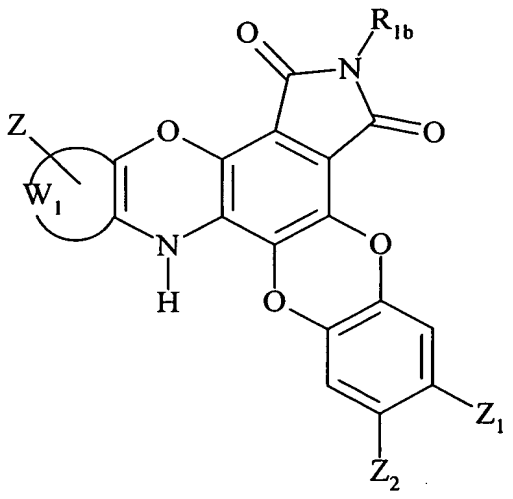


(I/a),

wherein P_G, R_{1a}, Z, Z_1, Z_2 and W_1 are as defined hereinbefore,
which compound of formula (I/a) is optionally treated with a compound of formula (X) :

$$R_{1b}—NH_2 \qquad (X),$$

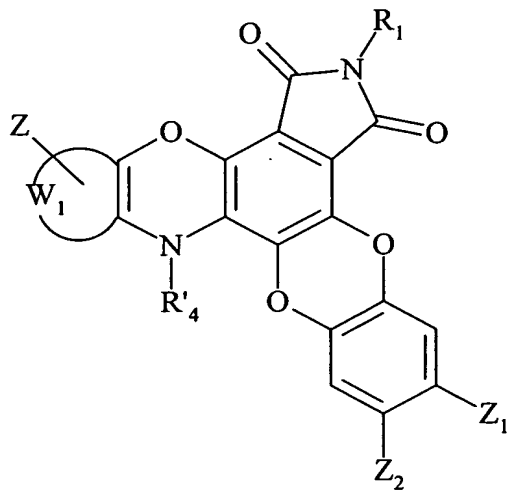
wherein R_{1b} has the same definition as R_1 in formula (I) but is other than a hydrogen atom or a methyl group, to yield the compound of formula (I/b), a particular case of the compounds of formula (I) :



(I/b),

wherein R_{1b}, Z, Z_1, Z_2 and W_1 are as defined hereinbefore,

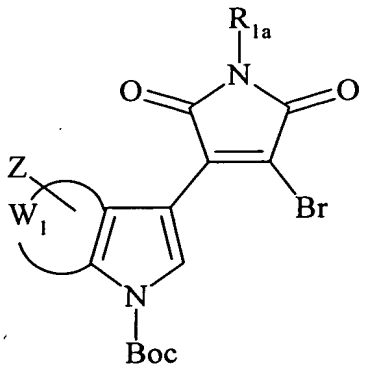
which compounds of formulae (I/a) and (I/b) constitute the compounds of formula (I/c) :



(I/c),

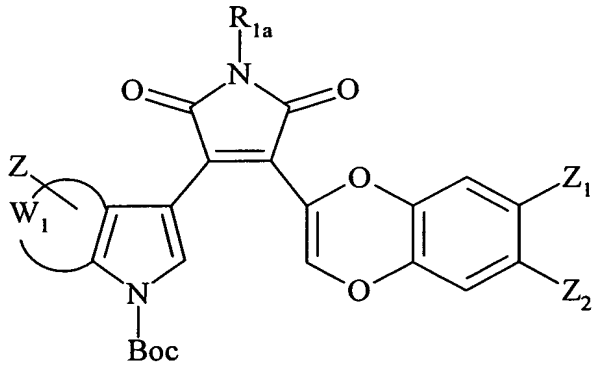
wherein R'_4 represents a hydrogen atom or a group P_G, and R_1, Z, Z_1, Z_2 and W_1 are as defined hereinbefore,

- or treated in the presence of bis(triphenylphosphine)palladium(II) chloride with a compound of formula (XI) :



(XI),

wherein Boc represents a tert-butoxycarbonyl group and R_{1a}, W_1 and Z are as defined hereinbefore, to yield the compound of formula (XII) :

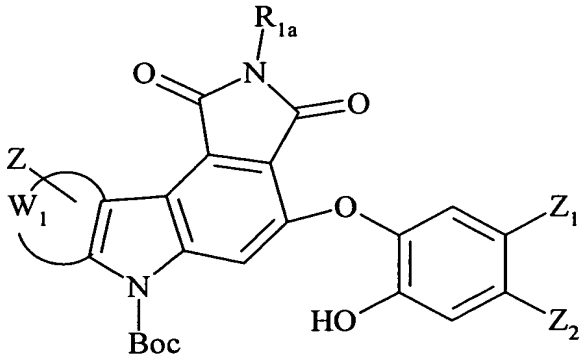


(XII),

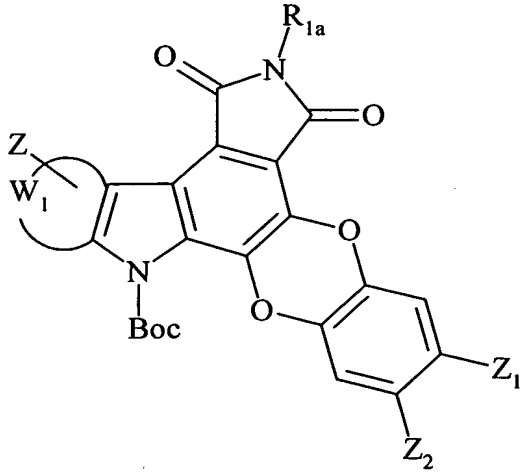
wherein Boc, R_{1a}, Z, Z_1, Z_2 and W_1 are as defined hereinbefore,

which compound of formula (XII) is :

- either irradiated with a UV lamp, in the presence of iodine, in a non-polar and aprotic solvent, to yield the compounds of formulae (I/d) and (I/e), particular cases of the compounds of formula (I) :



(I/d)

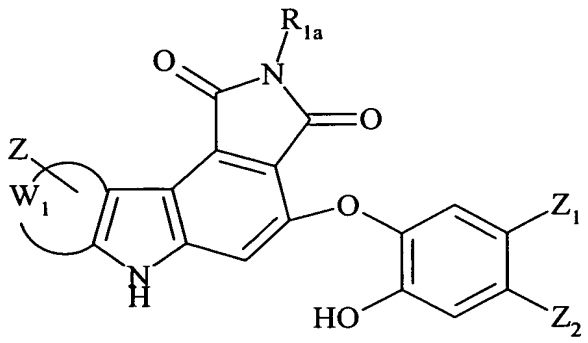


(I/e),

wherein Boc, R_{1a}, Z, Z_1, Z_2 and W_1 are as defined hereinbefore,

which compounds of formula (I/d) :

- ✧ optionally are subjected to deprotection of the amine function according to conventional methods of organic synthesis to yield the compound of formula (I/f), a particular case of the compounds of formula (I) :



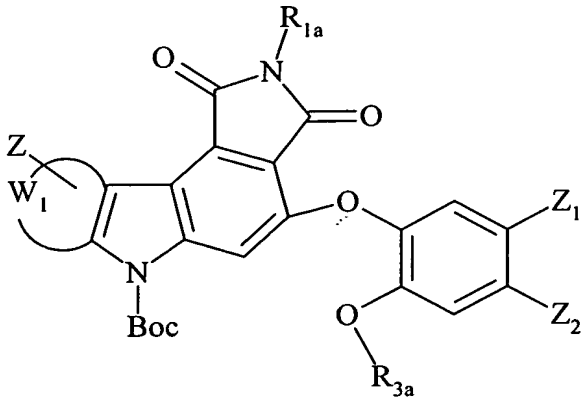
(I/f),

wherein R_{1a}, Z, Z_1, Z_2 and W_1 are as defined hereinbefore,

- ✧ or optionally are subjected to the action of a compound of formula (XIII) :

$$R_{3a}—G \qquad \text{(XIII)},$$

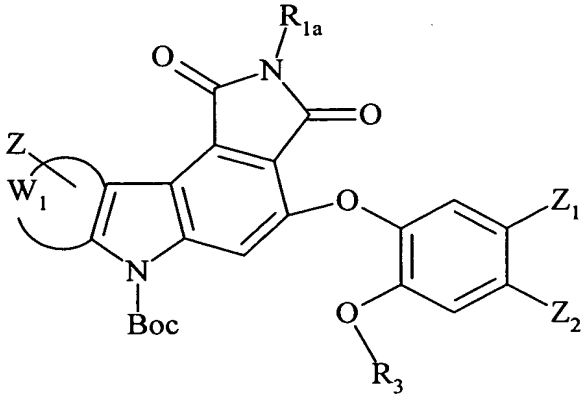
wherein R_{3a}, has the same definition as R_3 in formula (I) but is other than a hydrogen atom and G is as defined hereinbefore, to yield the compound of formula (I/g), a particular case of the compounds of formula (I) :



(I/g),

wherein Boc, R_{1a}, R_{3a}, Z, Z_1, Z_2 and W_1 are as defined hereinbefore,

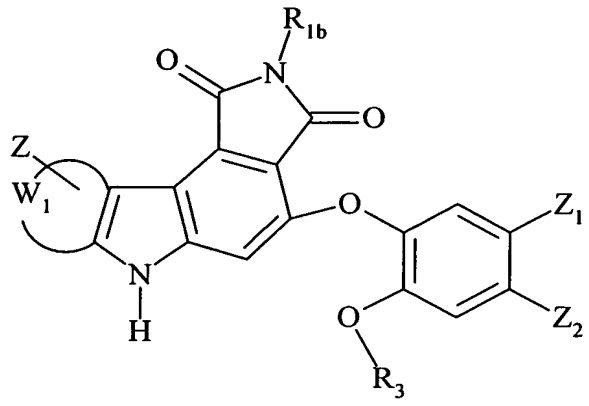
which compounds of formulae (I/d), (I/e) and (I/g) constitute the compound of formula (I/h) :



(I/h),

wherein Boc, R_{1a}, R_3, Z, Z_1, Z_2 and W_1 are as defined hereinbefore,

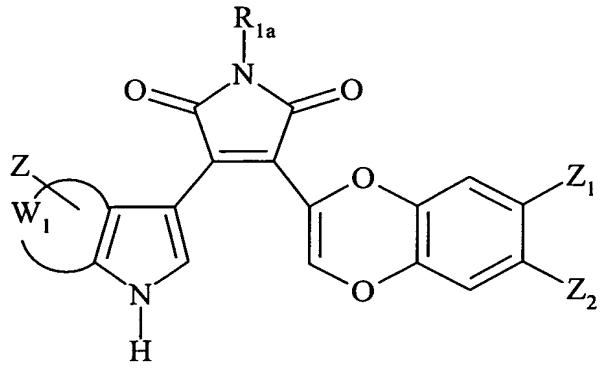
which compound of formula (I/h) optionally is subjected to the same reaction conditions as the compound of formula (I/a) to yield the compound of formula (I/i), a particular case of the compounds of formula (I) :



(I/i),

wherein R_{1b}, R_3, Z, Z_1, Z_2 and W_1 are as defined hereinbefore,

- or subjected to the action of hydrochloric acid to yield the compound of formula (XIV) :



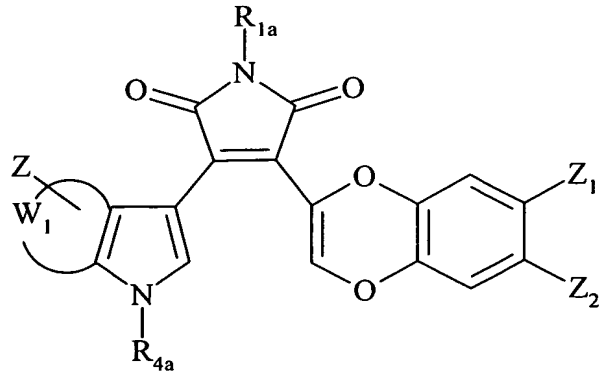
(XIV),

wherein R_{1a}, Z, Z_1, Z_2 and W_1 are as defined hereinbefore,

which compound of formula (XIV) is subjected to the action of a compound of formula (XV) :

$$R_{4a}—G \qquad (XV),$$

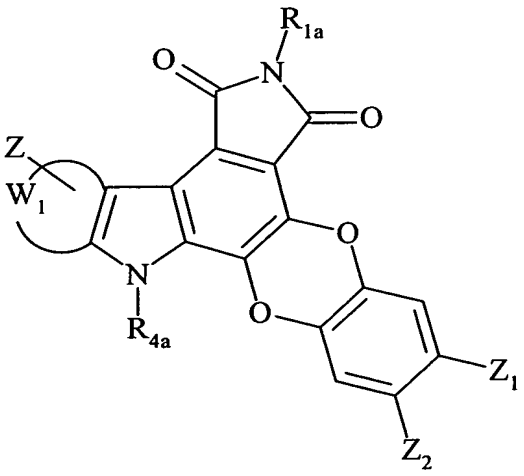
wherein G represents a leaving group and R_{4a} has the same definition as R_4 in formula (I) but is other than a hydrogen atom, to yield the compound of formula (XVI) :



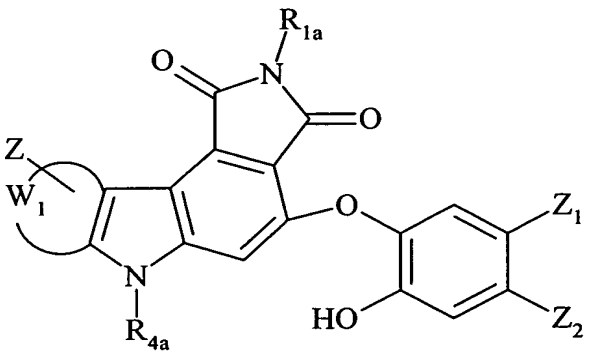
(XVI),

wherein R_{1a}, R_{4a}, Z, Z_1, Z_2 and W_1 are as defined hereinbefore,

which compound of formula (XVI) is subjected to the same reaction conditions as the compound of formula (XII) to yield the compounds of formulae (I/j) and (I/k), particular cases of the compounds of formula (I) :



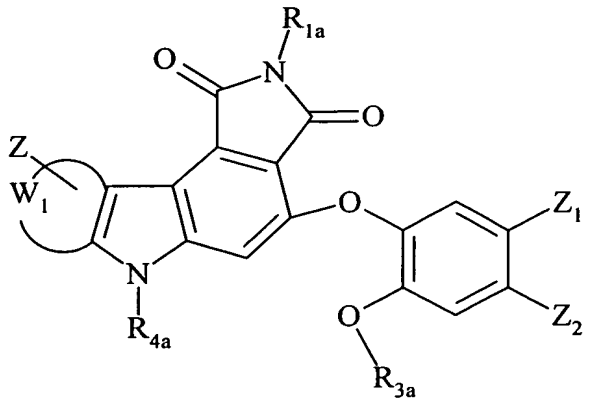
(I/j)



(I/k),

wherein R_{1a}, R_{4a}, Z, Z_1, Z_2 and W_1 are as defined hereinbefore,

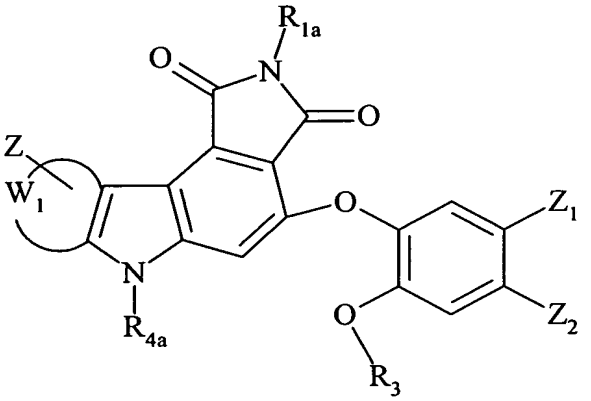
which compound of formula (I/k) optionally is subjected to the action of a compound of formula (XIII) as defined hereinbefore to yield the compound of formula (I/l) :



(I/l),

wherein R_{1a}, R_{3a}, R_{4a}, Z, Z_1, Z_2 and W_1 are as defined hereinbefore,

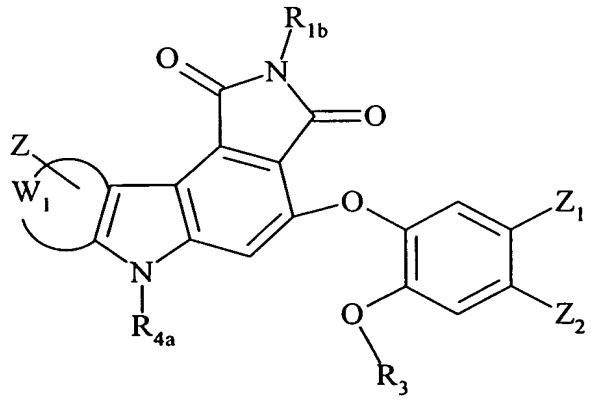
which compounds of formulae (I/j), (I/k) and (I/l) constitute the compounds of formula (I/m) :



(I/m),

wherein R_{1a}, R_3, R_{4a}, Z, Z_1, Z_2 and W_1 are as defined hereinbefore,

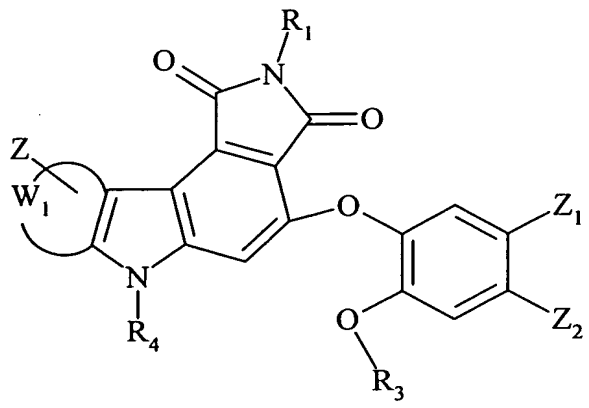
which compound of formula (I/m) optionally is subjected to the same reaction conditions as the compound of formula (I/h) to yield the compound of formula (I/n) :



(I/n),

wherein R_{1b}, R_3, R_{4a}, Z, Z_1, Z_2 and W_1 are as defined hereinbefore,

which compounds of formulae (I/e), (I/h) and (I/i), (I/m) and (I/n) constitute the compounds of formula (I/o) :



(I/o),

wherein R_1, R_3, R_4, Z, Z_1, Z_2 and W_1 are as defined hereinbefore,

which compounds of formulae (I/a) to (I/o) constitute the totality of the compounds of formula (I), which are purified, where necessary, according to conventional purification techniques, which may be separated, if desired, into their different isomers according to a conventional separation technique, and which are converted, if desired, into their N-oxides and, where appropriate, their addition salts with a pharmaceutically acceptable acid or base.

18. Pharmaceutical compositions comprising, as active ingredient, at least one compound of formula (I) according to any one of claims 1 to 16, alone or in combination with one or more pharmaceutically acceptable, inert, non-toxic excipients or carriers.

19. Pharmaceutical compositions according to claim 18 for use as medicaments, in the treatment of cancers.